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ABSTRACT

Teachers' views of the nature of science largely determine the way that they present science to their students. This study investigated the emerging philosophies of science and teaching in eight preservice science teacher interns. The study was conducted with a standardized open-ended interview format. Most interns viewed science as an exciting, dynamic process; however, the preservice teachers did not hold well-developed conceptions of their personal philosophies of science in general. (WRM)

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SCIENCE INTERNS' BELIEFS ABOUT THE NATURE OF SCIENCE AND TEACHING

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This study involves researching the emerging philosophy of science and teaching for eight preservice science teacher interns. The interns participated in a year long internship experience. The internship takes place during the final year of a five-year program. Each intern completed an undergraduate degree program in one of the sciences, and they completed an eighteen-hour block of education classes. In their undergraduate work they have spent hours in the classroom as a participant observer. During the internship year they worked with several different experienced teachers and with different age level students in various local schools. Each intern spent time in a middle level, junior high, and high school classroom. They also continued with course work during this period. The changes in their philosophy of science and teaching were tracked through an interview and subsequent opportunities at the middle and at the end of their teaching experience to edit the transcript of their interview.

The view of the teacher toward the nature of science is a major factor in determining the way that science teachers present material to students. This study was concerned with not only the way the interns' views evolved, but also with the way these philosophies affected their teaching. According to the National Science Education Standards, "The actions of teachers are deeply influenced by their perceptions of science as an enterprise and as a subject to be taught and learned. All teachers of science have implicit and explicit beliefs about science, learning, and teaching" (National Research Council, 1996, p. 28). Brickhouse (1990) found in her study that "the teachers' understanding of what science is and how students learn science in schools formed a consistent system of beliefs for guiding classroom instruction" (p.60). This is important because, according to Brickhouse, "teacher education will make little impact on practice, if beginning teachers are unable to implement instruction consistent with their beliefs about

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science" (1990, p. 60).Methodology All of the MAT science interns during the 1997-98 school year were included in this study. There were three females and five males. Participation in this research was voluntary. The participants signed an informed consent form, and were able to drop out of the study at anytime. There were no incentives given to any of the participants.

The study of the interns' philosophy of teaching and science was conducted by the use of a standardized open-ended interview format. In this type of interview "the exact wording and sequence of questions is determined in advance" and "questions are asked in a completely open-ended format" (Patton, 1990, p. 289). The advantage to this type of interview is that each time the interviews are conducted the questions asked are exactly the same for each person and are written out in advance. Careful consideration was used in the preparation of the interview questions. Using a standardized open-ended interview format reduces interviewer effect, makes the interview systematic, and reduces the necessity for interviewer judgement during the interview. According to Patton, "The standardized open-ended interview also makes data analysis easier because it is possible to locate each respondent's answer to the same question rather quickly and to organize questions and answers that are similar" (1990, p. 285). Questions were aimed toward understanding the interns' philosophy of teaching, application of their philosophy of teaching to the classroom, philosophy of science, and how their philosophy of science translated into classroom practices. The interns were interviewed during the summer prior to the beginning of the school year, and the beginning of their field experience. All of the interviews were audio taped and then transcribed.

Questions used for the interview were adapted from the Salish I Research Project Teachers' Pedagogical Philosophy Interview First Year Teachers (Salish, 1997). The Salish I Research Project was sponsored by the U.S. Department of Education and the Office of Educational Research and Improvement. This project brought together nine institutions which prepare science and mathematics teachers to study influences on new teachers and their students. Salish II was a continuation of the work started in Salish I. In the Salish II project researchers

from twelve universities used the findings of Salish I as background and defining materials for their research. This study is part of the Salish II research project.

The typed transcripts were returned to the interns in January. They were asked to review their responses and encouraged to revise their original responses to the interview questions by editing the transcripts. Changes to their original answers were to reflect changes in their views since the original interview. These revisions were then incorporated into the original transcript. The revised transcripts were returned to the interns at the completion of the school year in May. Again they were asked to edit the transcripts to reflect changes they had in their beliefs about teaching and science.

The analysis of data took place in several stages. First the data was open coded, allowing for the "naming and categorizing of phenomena through a close examination of the data" (Strauss and Corbin, 1990, p. 62). Axial coding, where connections are made after the open coding, and selective coding, where data is systematically related to other categories and those relationships are validated, was done with the aid of the NUD*IST software package. This software allows for all of the documents, transcripts and observation records to be searched simultaneously, reducing the possibility of missing a connection between the various responses from the interns.

Results

The students had widely varying views in their philosophies of teaching and incompletely developed concepts of a philosophy of science. The revisions of their original interviews were on the whole minor, with little change made by the midpoint of the year. The final revisions of the interviews by the interns, reflecting their end of year views added little to the overall view of their philosophies. Of the five interns who returned final revisions, only two made changes to their views, the others were minor grammar corrections.

For the eight interns, their idea of what science is and how they want the students to view science were fairly similar. They perceived science as a way of viewing the world around them. They looked at science as a scheme by which we make sense our surroundings. Of great

importance to most of the interns was that students share their enthusiasm in the study of science. It is a love that they wish to pass on to their charges. About half of the interns were also concerned with the procedures of science. Science consists of studying the world using the systematic approach of the scientific method. Most did not view science as static, but looked at it as a process that could and did change over the course of time. A few of the interns' responses to the question of "what is science?" are:

> Intern #5
> Science is a way of thinking. I've been practicing this. But, science is a way of thinking, it's asking the how and the why. And when we think about science we are always asking questions and so the whole purpose of science is just to answer these questions. It's a way about finding the answers and we make hypotheses about something that we think is going to happen and so then we test what we think and then we have all this data that we gathered and then we draw conclusions based upon this data that we collected.

> Intern #4
> Refers to a body of knowledge as well as how that knowledge is gained. Science is science. It's a body of knowledge that has been discovered. Well, it's like always been there. The laws, of course what are the laws of physics? Like the laws of physics, they have always been there, but it has taken time and people to discover them. It's knowledge that is discovered as the result of studying problems. What is science? I don't know.

> Intern #8
> Oh boy. Science it's everything. Pretty much. It's a way of viewing the world. It is, although it is a subject area in school, and in school you might just study one part of science, or one area that is pretty specific, science encompasses everything. It, I guess, instead of saying it's a way of looking, well it is a way of looking, or perceiving, and, um, not analyzing, but synthesizing the situation and the things around you. Uh, it's like, I'm not sure because I am not a history major, but history is studying the past and possibly things that might happen in the future, where science is, you know, science is another way you can look at history and the things that happened in history and the way things happened in history. I mean you could apply it to anything, so it would be science encompasses everything and it is a way of interpreting and synthesizing and applying what you know.

Some responses from the interns to the question of how they want students to view science are:

> Intern #4
> Um, I think I would want them to view science as something interesting, something relevant, something possible that they can do. Um, I guess that's all for now.

Intern #5
Okay, not everyone is a scientist, so I would not try to make anyone love science. But I think that I would want them to have an understanding of what science is and the role it plays in everyday life and how the importance of it.

Intern #7
I would hope my students aren't so afraid of science, afraid of all the knowledge that can be gained, all of the information that's out there. Science every day is expanding. Hope's they find it inquisitive, hope that they are interested in finding out more. Science is so broad that you can teach one thing and hopefully it will spark their interest. And they can move on in their own interest and do their own research and maybe make a life out of some research area that they are interested in.

The concepts of facts, laws and theories were not well defined in the minds of the majority of the interns. Some of the ideas they voiced were that facts are measurable, unchanging, and truths. Facts deal with minute details, do not change over time, are hypotheses that have been proven, are testable, and are reliable. Laws are formed from facts, facts support laws, laws are not going to change, they explain relationships, and they are testable and verifiable. The hardest of these concepts for the interns to define was theory. Most interns expressed discomfort with their own definition of theory. Some used the idea that theories cannot be proven true, only false. Theories were viewed as changeable, as ideas, and as formed from laws. One intern stated that theories are beliefs. The inadequacy of the interns' interpretations can be seen in that some interns would start with a coherent answer when asked what facts, laws, and theories are in science, but this would quickly give way to confusion. Other seem to have heard definitions of facts, laws, and theories, but have not kept the concepts separated. Some examples of the interns' responses are:

Intern #3:
Theories is it's, um, if I can remember correctly, it's something that the scientist believes it needs a lot of evidence towards its correctness, but it can never be proved true, but it can be proved false. A fact is something that is accepted as, um, something that is accepted as correct, not false, not untrue, a fact is something that is can be proved through I guess statistics or something to that effect. Maybe. And a law is something like the law of thermodynamics, it is proved to be true in almost all cases and maybe it cannot be proved to be false, I am not real sure on that, It's also a guiding point for other aspects of science that are discussed that is not very clear.

Intern #2:
Facts are things that you find that are, um, true to the sense they can be proved by some sensory reading or UV. That would be a fact about a specific thing. A theory, I, ah, think this is again all based on the human sense and theory is again based on just what happens to matter and, uh, what happens to things in our realm of sensing, it can never be proved it can only be disproved. And that is something we discussed in class, um. Beyond a theory and that leading to a law is a mathematic, it seems that mathematically proved to occur in all circumstances, that is has occurred so far. I hope that, I think I've described about as well as I can.

Intern #6
I, er, ah, hmm. Theories depend on laws. Laws depend on facts. It's kind of a pancaked effect. Facts are ideas that, and theories, facts, theories a different word than what I wanna to use. Theories and hypothesis are ideas and, I think, facts are the hypotheses that have been proven. Uh, enough facts are gathered to come up with a law. The law, it can explain a theory. A theory is always testable. It can be adapted or changed to explain it. I think of gas laws, coming to mind, you can prove them, the facts - certain characteristics prove the law. There's the gas theories, they're all intertwined, enough facts give you a law and the laws develop into a theory.

The interns seemed to agree on the idea that teaching should be based on respect for the students. This was manifested in answers that included: let the students know you care; show the students respect and honesty; offer education to all students; work with students from all backgrounds, learning styles, and beliefs; be honest with the students; and as a teacher you need to be flexible and accommodating. Some answers given by the interns are:

Intern #1
I think that the number one, the number one principle would be respect, because if you don't respect your students you are not going to get them to respect you. And I think you need to be honest. In subject matter, if you don't know something than I think you need to be honest and tell your students that you don't know that and be willing enough to investigate and find the answer for them, so I guess I would just say respect and honesty, I guess those are more morals than principles. That is my short concise answer.

Intern #3
I believe that teaching should be first based on educating the students despite who they are or where they are from. It's important to deal with each student differently because each and every student will have different learning styles, different beliefs, different systems. But teaching for first I mean mostly all important is to educate the children to help them to build a foundation for their lives. Same as above and to implement meaningful material that they will be able to apply to everyday life.

What should be taught in the schools, for most of the students would be government regulated through state frameworks. A few of the interns also felt that the textbooks should drive the curriculum to varying degrees. One intern felt that the teacher's background and knowledge area played an important role in what was taught.

> Intern #2
> You know, I don't think that that's my decision at all. I would hope that I would have a set of guidelines and wait. Um, I guess I would try to pick things most relevant to the regional and science issues at hand. Things that are popular right now, the rainforest is something I would leave out basically because it is so removed from what we are doing we could do so much more with our, our environmental issues at hand here in Arkansas. So I guess I would try to make it more reflective of the community and society where I am teaching is.

> Intern #6
> First off, what to teach and what not to teach wouldn't be a choice that I would probably have as a beginning teacher. I think the curriculum would be set forth for me. However, I think good common sense can go into saying what to teach and what not to teach. For example, the cloning project. I'm sure as a chemistry teacher I could show how different cells and different chemicals are reacting, however, getting into the rights and wrongs of it, that's not my department. That's the children's department. I don't think I should be able to decide what's right and what's wrong. I think that we should have all open viewpoints, but not make a clear decision. That comes into a moral dilemma, and I don't see myself handling the moral dilemmas right off the bat. Now if (a moral dilemma) should arise, like I said, I hope we could have viewpoints and let the children decide what they think is right and wrong. I don't want to say that my way is right and leave it at that or my way is wrong, and leave it at that. I think that we should - we're all open - we're all learning. That's kind of a scholar-practitioner, you learn as you go. But, as deciding as what to teach and what not to teach, I think just common sense would handle that situation.

A variety of ideas were expressed as to how students learn best. Most of the interns favored hands-on activities and manipulatives. Discussions were also popular with the interns, both as a teaching method and as a way of gauging student learning. One intern felt that worksheets were important for making the knowledge concrete to the students.

Several interns mentioned reflective writing as important for themselves and the students. For almost all of the interns, classrooms should be interesting inviting places with posters, plants,

animals, and resources available. The interns felt that a stimulating environment, with place for the students to explore would be most appropriate to learning science.

Conclusions

Many opinions of the interns were very progressive and resembled several aspects of the National Science Education Standards. One very positive aspect of the interns' perspectives about teaching was their respect for the students. The idea of respecting the students is directly reflected in the National Science Education Standards, "Display and demand respect for the diverse ideas, skills, and experiences of all students" (National Research Council, 1996, p. 46). The view of the majority of the interns toward what should be taught in the classroom was based on the state mandated science frameworks. In the National Science Education Standards they also suggest frameworks, but stress the necessity to remain flexible to the changing needs of students to reflect topics from inquiries and experiences. It continues by stating that science content should "meet the interests, knowledge, understanding, abilities, and experiences of students" (National Research Council, 1996, p. 30). The use of discussion in the classroom is listed as one of the areas that requires emphasis in the classroom in the National Science Education Standards. This directly parallels the interns' view of discussions in the classroom. Finally, the interns viewed the classroom as a place that should provide a stimulating environment to be explored by the students. The National Science Education Standards suggest that this be taken one step further and that the students take a role in designing the learning environment, that the setting is supportive of scientific inquiry, that resources are available, and that the environment is safe.

The major concern raised by this investigation is that the interns do not have a well-developed concept of their own philosophies of science. Although they are developing sound teaching philosophies, if they do not fully understand the subject matter they are teaching, will the students be able to develop their own scientific philosophies and a greater understanding of the subject? In the National Science Education Standards it states, "Teachers can be effective guides for students learning science only if they have the opportunity to examine their own

beliefs, as well as to develop an understanding of the tenets on which the Standards are based" (National Research Council, 1996, p. 28).

The methods used in this study should be revised for future investigations. When the interns were given back their original transcribed interviews, most did not see a need to change what they had written. In a study that is being conducted with this year's interns, the interns are being interviewed three times. This method is revealing greater changes in the responses of the interns.

Brickhouse suggested that further research be conducted "on teachers' development of pedagogical content knowledge in science in the context of teacher education, as teachers progress through courses in science and pedagogy and their clinical experience" (1990, p. 61). Helping preservice science teachers form an understanding of science and their own philosophies of science may be the key to the improvement of science education.

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